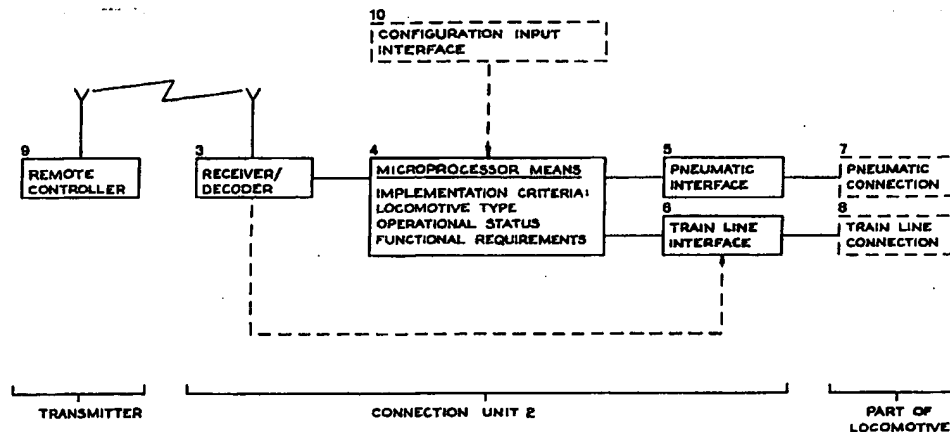




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b>  <b>B61L</b>	<b>A2</b>	<b>(11) International Publication Number:</b> <b>WO 99/05015</b>  <b>(43) International Publication Date:</b> 4 February 1999 (04.02.99)
<b>(21) International Application Number:</b> PCT/NZ98/00111  <b>(22) International Filing Date:</b> 22 July 1998 (22.07.98)  <b>(30) Priority Data:</b> 328389                      22 July 1997 (22.07.97)                      NZ  <b>(71) Applicant (for all designated States except US):</b> TRANZ RAIL LIMITED [NZ/NZ]; Corner Featherston Street & Bunny Street, Wellington (NZ).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> COOMBES, Ian [NZ/NZ]; Corner Featherston Street & Bunny Street, Wellington (NZ).  <b>(74) Agents:</b> WEST-WALKER, Gregory, James et al.; Russell McVeagh West-Walker, 171-177 Lambton Quay, Wellington 6001 (NZ).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>Without international search report and to be republished upon receipt of that report.</i>

(54) Title: LOCOMOTIVE REMOTE CONTROL SYSTEM



## (57) Abstract

A connection unit adapted to be connected to the train line and brake line connectors of a locomotive as part of a remote control system for the locomotive, the connection unit comprising receiver means for receiving remote control instructions; interface means for connection to the train line and brake line connectors; and microprocessor means arranged to determine the locomotive's configuration, interpret the received remote control instructions, modify said instructions dependent on the locomotive's configuration, and operate the interface means such that the locomotive is controlled according to the locomotive configuration and the remote control instructions.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## LOCOMOTIVE REMOTE CONTROL SYSTEM

### FIELD

- 5 The present invention comprises a locomotive remote control system.

### BACKGROUND

Rail operators require both mainline locomotives for train haulage and shunt  
10 locomotives for shunting functions. Remote control locomotives which can be  
controlled away from the vehicle are advantageous for railyard shunting and are  
usually specially fitted out for remote operation. Manually controlled and remote  
control locomotives are often dedicated to their respective functions and cannot be  
interchanged without refitting.

15

US patent 4,687,258, discloses a portable remote control system which includes a  
receiver unit which plugs into a locomotive's train line socket to control train line  
circuits. Some mainline locomotives are equipped with a "train line" (usually an  
electrical control signal interface) and brake control line (usually pneumatic airline  
20 interface) which enable one locomotive to be linked with another locomotive for  
multiple operation. The portable remote control system also includes pneumatic  
equipment for connection into the locomotive's pneumatic braking systems. The  
system bleeds air from the train air brake line to control the independent locomotive  
brakes. The bleed of air is limited so the small loss of air from the train air brake  
25 line does not apply the train brakes (which are normally operated by a reduction in

air pressure). A transmitter unit remote from the locomotive allows an operator to send commands or control signals to the receiver unit which are then implemented by control of the train line circuits and braking systems. The system is dedicated to one specific type of train line socket and train line circuit arrangement as received  
5 commands are implemented directly by energising a corresponding relay. The system also acts as a slave to the transmitter commands, implementing the commands irrespective of whether they represent "safe" or otherwise allowable commands.

## 10 SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved or at least alternative locomotive remote control system.

15 In broad terms in one aspect the invention comprises a connection unit adapted to be connected to the train line and brake line connectors of a locomotive as part of a remote control system for the locomotive, the connection unit comprising:

receiver means for receiving remote control instructions;

20

interface means for connection to the train line and brake line connectors;

and microprocessor means arranged to determine the locomotive's configuration, interpret the received remote control instructions, modify said instructions  
25 dependent on the locomotive's configuration, and operate the interface means such

that the locomotive is controlled according to the locomotive configuration and the remote control instructions.

For the purposes of this specification, the locomotive's configuration refers to the type of locomotive and its operating systems which will vary from locomotive type to locomotive type. The locomotive's configuration may be identified directly by the microprocessor means through the interface means, or alternatively configuration information details may be manually entered into the microprocessor means through a further dedicated manual interface means.

10

Preferably the microprocessor means is arranged to monitor the locomotive's operating systems such that operation of the interface means further depends on the state of the operating systems. For example, upon receiving a brake release instruction, the microprocessor means may query whether the locomotive braking system has adequate air pressure before releasing the brakes.

15

Preferably the connection unit is portable and is directly connectable to the train line and brake line connectors. Preferably the connections are the same as those required for multiple operation for the locomotive. Preferably the connections are such that any locomotive designed to operate in multiple does not require any further modifications to interface with the connection unit.

20

Preferably the microprocessor means may be configured such that the interface means operation is further dependent on the locomotive's functional situation. For example, in certain shunting operations, the locomotive may be restricted to certain

25

maximum speeds. The microprocessor means may also be configured to implement ramped or stepped throttle control, or to cancel the throttle before applying the braking system, for example.

- 5 Preferably the microprocessor means further includes fault logging and/or event recording facilities.

Preferably the microprocessor means is a programmable logic controller (PLC).

- 10 Preferably the connection unit further incorporates additional features for controlling locomotive systems not normally controlled through the train line or brake line connectors, for example locomotive lighting controls or horn.

- Preferably the connection unit further incorporates additional features for  
15 controlling systems external to the locomotive, for example coal discharge sites, points operation, indicator lights, or doors.

In broad terms in another aspect the invention comprises a remote control system for a locomotive comprising:

20

a remote controller means to transmit remote control instructions;

a connection unit adapted to be connected to the train line and brake line connectors of the locomotive, the connection unit comprising:

25

a receiver means for receiving the remote control instructions;

interface means for connection to the train line and brake line connectors;

- 5 and microprocessor means arranged to determine the locomotive's configuration, interpret the remote control instructions, modify said instructions dependent on the locomotive's configuration, and operate the interface means such that the locomotive is controlled according to the locomotive configuration and the remote control instructions.

10

The invention provides a portable remote control system for locomotives which is easily connectable and adaptable to different locomotive configurations, and in addition only implements received commands if they are safe or meet other implementation criteria.

15

The invention provides full locomotive control by remote control within safe and otherwise allowable operating parameters for the particular locomotive and its functional requirements. For example there are no operator imposed restrictions on the system's capacity to apply or release brakes.

20

In broad terms in another aspect the invention comprises a method of remotely controlling a locomotive comprising:

transmitting locomotive remote control instructions from a location remote from the

25 locomotive;

receiving the locomotive remote control instructions at the locomotive;

identifying the locomotive configuration;

5

interpreting and modifying the received locomotive remote control instructions dependent on the locomotive configuration; and

operating the locomotive according to the modified locomotive remote control  
10 instructions.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

A preferred embodiment of the remote control system of the invention will now be  
15 described, by way of example and without intending to be limiting, with reference to the accompanying drawings in which:

Figure 1 is a schematic drawing of the preferred form system,

20 Figure 2 is an electrical schematic diagram of the connection unit of the preferred form system, and

Figure 3 is a pneumatic block diagram showing connections between the connection unit of the preferred form system and a locomotive's pneumatic systems.

25



**DESCRIPTION OF THE PREFERRED FORM**

The preferred system shown in schematic form in Figure 1 comprises a remote controller unit 9 in radio contact with a locomotive connection unit 2 comprising, a receiver/decoder unit 3, microprocessor means 4 including memory means, a pneumatic interface unit 5, and a train line interface unit 6. The connection unit 2 may optionally further comprise a locomotive configuration input interface 10.

The connection unit 2 is shown in more detail in Figures 2 and 3 and is installed in a locomotive using the pneumatic and train line interfaces 5 and 6. The interfaces 5 and 6 are adapted to allow both control and monitoring of locomotive operating systems, including safety circuits or systems. Preferably the pneumatic and train line interface 5 and 6 connections are similar or equivalent to those used to connect the locomotive to another locomotive for multiple operation.

15

The train line interface 6 includes a train line plug or connector 16 which connects with a corresponding train line socket or connector 8 on the locomotive. The train line plug 16 may be configured to connect with train line sockets 8 of all locomotives used with the system, or adaptors (not shown) may be connected between the train line plug 16 and socket 8 to accommodate different socket 8 configurations. As a further alternative, the train line interface 6 may include a number of train line plugs 16, each with different configurations to connect with different train line sockets 8.

Locomotive operations such as throttle, direction and headline/marker light control for example, are achieved using relays connected into the appropriate train line circuit by the train line plug 16. Preferably the relays used are specialist rail vehicle miniature relays such as are manufactured by ZTR Controls, Canada, for example.

- 5 Throttle control (where controlled by train line connection) is preferably implemented by operating relay contacts in a sequence compliant with the level of throttle commanded. Other switching arrangements or control systems could alternatively be used.
- 10 The locomotive's operating status as well as safety circuits are monitored via the train line plug 16 connections or contacts. For example the locomotive's alarm circuits and control circuits can be interrogated via these connections. Preferably, the connections are opto-couple connections.
- 15 The pneumatic interface 5 is shown in block diagram form in Figure 3 and includes connections as shown to the locomotive's pneumatic systems including the locomotive main reservoir air supply 41, the train brake line 42, the locomotive brake line 43, ancillary systems such as the horn (not shown), and if used the pneumatic throttle 44. Adaptors (not shown) may be used to connect the locomotive  
20 pneumatic systems to the pneumatic interface 5.

The pneumatic interface 5 comprises a locomotive main reservoir air supply pressure switch 31, a locomotive brake line pressure switch 32, a train brake pressure transducer 33, a locomotive brake pressure transducer 34, a train brake  
25 volume booster 38, a train brake emergency solenoid valve 36, a locomotive brake

emergency solenoid valve 37, and ancillary control air regulators and filters as shown. The interface 5 also includes a pneumatic throttle pressure transducer 35 for locomotives utilising a pneumatically controlled throttle. The pressure transducers 33, 34 and 35 are preferably current loop controlled.

5

The pneumatic interface 5 may also include additional pneumatic solenoid valves (not shown) to control for example, the supply of air to the horn and other miscellaneous pneumatic equipment. The interface 5 may also include an integral horn.

10

The locomotive main reservoir air supply 41 is connected to the locomotive main reservoir air supply pressure switch 31, which monitors the reservoir pressure, and to the pneumatic interface 5 control air system.

- 15 The locomotive main reservoir air supply 41 is also connected to the input of the train brake volume booster 38. The train brake line 42 is connected to the output of the train brake volume booster 38 which is controlled by the train brake pressure transducer 33 via the train brake emergency solenoid valve 36. The train brake is applied by a reduction in pressure in the train brake line 42. In an emergency
- 20 braking situation, this can be achieved by control of the train brake pressure transducer 33 to control the train brake volume booster 38, or by operation of the train brake emergency solenoid valve 36.

The volume booster 38 is typically employed for train brake control and has its signal pressure sourced from the train brake pressure transducer 33 when high volume air control is required.

- 5 The locomotive brake line 43 is connected to the locomotive brake pressure switch 32 which monitors the locomotive brake line pressure. The locomotive brake line 43 is also connected to the locomotive brake pressure transducer 34 via the locomotive brake emergency solenoid valve 37. The locomotive brake is applied by an increase in pressure in the locomotive brake line 43. In an emergency braking situation, this  
10 can be achieved by control of the locomotive brake pressure transducer 34 and/or the locomotive brake emergency solenoid valve 37.

The system provides two independent methods of braking control (the train and locomotive braking systems), each with pressure transducer control (33 and 34  
15 respectively). Upon an emergency braking situation, all pressure transducers are set to emergency braking pressure. The train brake volume booster 38 (where used) is exhausted to atmosphere by the train brake pressure transducer 33 or the train brake emergency solenoid valve 36. The locomotive brake has emergency brake pressure applied through locomotive brake pressure transducer 34 or the  
20 locomotive brake emergency solenoid valve 37.

Preferably the pressure transducers provide a maintaining brake system using a feedback arrangement to maintain a required pressure level. Selected pressure levels are repeatable and are controlled by the microprocessor means 4 and the  
25 current loop control method. Pressure levels depend on remote control instructions

as conditioned by the microprocessor means 4 for the type of locomotive and the locomotive's functional requirements.

5 The system is configured to be fail-safe such that if a fault or failure occurs in either the remote control system (including the remote controller 9 and the connection unit 2) or is detectable on the locomotive itself, the system is configured to apply the emergency braking system for example. The system is preferably configured such that each brake system (locomotive and train) is independently fail-safe.

10 The system is typically configured to connect with locomotives using Westinghouse 26L pneumatic braking systems or similar.

The system can also be configured to control a locomotive where only a single braking system is required (typically the locomotive brakes).

15

The remote controller 9 is operated by an operator to remotely control the locomotive. The controller 9 transmits encoded signals to the connection unit 2 corresponding to the operator's commands. The controller 9 is required to be in constant radio contact with the connection unit 2, which is configured, for example, 20 to apply the emergency braking system if radio contact is lost.

The receiver/decoder 3 of the connection unit 2 receives and decodes the encoded signals transmitted by the controller 9. The receiver/decoder 3 output logic or control signals are dependent on the operator's commands as entered into the 25 remote controller 9.

The controller 9 and receiver/decoder 3 may be standard units manufactured by Theimeg Elektronikgerate GmbH & Co, Germany.

- 5 The microprocessor means 4 includes memory means and may be implemented as a Programmable Logic Controller operating according to a logic program. The microprocessor means 4 is programmed to implement the non-locomotive specific commands of the receiver/decoder output by controlling appropriate train line 5 and/or pneumatic 6 interface connections depending on the specific locomotive
- 10 type, to operate the specific locomotive as commanded. The received commands will only be implemented if they are allowable and "safe" for the specific locomotive type and its selected functional requirements.

- The microprocessor means 4 monitors the operating status and safety circuits of the
- 15 locomotive to ensure that requested commands if implemented, will result in safe operation of the locomotive. For example, a command to release the emergency braking system will only be implemented if the locomotive main reservoir air supply 41 contains sufficient air to reapply the locomotive braking system 43. As a further example, the microprocessor means 4 may only implement an increase throttle
- 20 command if the locomotive is below a pre-determined maximum speed limit. As a further example, the microprocessor means 4 may only institute a change in direction if adequate locomotive brakes 43 are applied.

The system may also be constructed and configured such that the connection unit 2 sends operating and safety system status signals back to the controller 9, for example to indicate why a throttle command hasn't been implemented.

- 5 The microprocessor means 4 may be configured to determine the locomotive type from the current connection arrangement of the pneumatic and train line interfaces. Alternatively, the locomotive type may be manually entered using a dedicated input interface 10.
- 10 The microprocessor means 4 contains a "database" which includes a set of locomotive types to be used with the system together with a list of operating parameters for each locomotive type. The parameters include allowable commands, safety ranges such as minimum-safe level of locomotive brake air pressure required before brake release is allowable, whether the locomotive throttle is pneumatically
- 15 or train line controlled, as well as the particular connection arrangements required, such as which relay will be controlling which train line circuit after the train line plug 16 is connected to the train line connector 8.

- The database also includes a set of commands corresponding to the
- 20 receiver/decoder 3 output signals, for example a throttle forward command or a switch marker light on/off command. The microprocessor means 4 compares the received commands with the locomotive's operating parameters as well as the current operating status of the locomotive to determine whether they are allowable commands. If allowable, the microprocessor means 4 implements the commands by
- 25 appropriate control of the pneumatic 5 interface and the train line plug 16.

The database also includes the locomotive's current selected functional requirements which further conditions the received commands by only allowing commands appropriate to the selected functional requirements. Special functional requirements may also be selected using the configuration input interface 10.

The connection unit 2 can be embodied in several ways to implement allowable received commands. The microprocessor means 4 may directly monitor the received commands via the receiver/decoder 3 output and, if allowable, implement the command by directly controlling the appropriate relay or other interface 5 or 6 element according to the locomotive type.

Alternatively, the receiver/decoder 3 outputs may be used to directly control interface 5 or 6 elements, for example the relays of the train line interface 5 as shown in Figure 2. In this embodiment, the microprocessor means 4 enables or disables the relay or relays to be controlled by the receiver/decoder 3, depending on the locomotive type and whether the commands are allowable for safety or other reasons. For example, the microprocessor means 4 may enable one of a series of throttle relays which is appropriate to the specific locomotive to which the connection unit 2 is connected. All throttle relays may receive the receiver/decoder 3 throttle signal, however only the relay appropriate to the particular locomotive is enabled by the microprocessor means 4. The enabling of this relay will also further depend on the operating status and parameters of the locomotive as outlined above.



Preferably the microprocessor means 4 is implemented using a programmable logic controller (PLC) operating according to a logic programme which incorporates the above mentioned database parameters.

- 5 Preferably the microprocessor means 4 includes fault logging and event recording capacity.

Preferably the system is contained in one or more "suitcase" size enclosures to facilitate portability.

10

The system may be enhanced to include automated train movements or multiple controls upon receipt of a single command. For example, the system may be configured to follow sequences such as release brakes, apply permitted throttle (for permitted speed) and travel a predefined route, reduce throttle and reapply brakes.

15

As a further alternative, the system may be incorporated into a larger remote control regime for multiple locomotives in a railyard for example, each locomotive being remotely controlled by an overall controller which co-ordinates their movements.

20

As well as multiple operation capable locomotives, the system can also be configured to connect to locomotives without this capacity, but which have been modified to allow access to and control of their braking and throttle systems.

The microprocessor means 4 provides versatility for additional features or changes in functionality to be introduced. For example, the system may be configured to control remote packs located within the train to perform overriding braking functions on selected vehicles. As a further example, the microprocessor means 4  
5 may be configured to enable inter-system communications using for example RS485 overlaid on dedicated or otherwise occupied train line wiring.

The foregoing describes the invention including preferred forms thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be  
10 incorporated within the scope hereof.

**CLAIMS**

1. A connection unit adapted to be connected to the train line and brake line connectors of a locomotive as part of a remote control system for the locomotive, the  
5 connection unit comprising:  
  
receiver means for receiving remote control instructions;  
  
interface means for connection to the train line and brake line connectors; and  
10  
microprocessor means arranged to determine the locomotive's configuration, interpret the received remote control instructions, modify said instructions dependent on the locomotive's configuration, and operate the interface means such that the locomotive is controlled according to the locomotive configuration and the  
15 remote control instructions.
2. A connection unit according to claim 1 wherein said receiver means comprises a radio receiver for receiving said remote control instructions by radio.
- 20 3. A connection unit according to claim 1 or claim 2 wherein said interface means comprises a pneumatic interface unit and a train line interface unit.
4. A connection unit according to claim 3 wherein the pneumatic interface unit comprises a plug configured to connect to a multiple number of train line

sockets or a multiple number of plugs each for connection to a different type of train line socket.

- 5        5.        A connection unit according to claim 3 wherein the pneumatic interface unit comprises a locomotive main reservoir air supply pressure switch, a locomotive break line pressure switch, a train brake pressure transducer, a locomotive brake pressure transducer, and optionally a pneumatic throttle pressure transducer.
- 10       6.        A connection unit according to any one of the preceding claims wherein the microprocessor means contains a data base of instruction information for a multiple number of locomotive types.
- 15       7.        A remote control system for a locomotive comprising a connection unit adapted to be connected to the train line and brake line connectors of a locomotive according to any one of the preceding claims and a remote control means operable by a user to transmit remote control instructions to the connection unit.
- 20       8.        A method of remotely controlling a locomotive comprising:  
  
transmitting locomotive remote control instructions from a location remote from the locomotive;  
  
receiving the locomotive remote control instructions at the locomotive;  
  
25       identifying the locomotive configuration;

interpreting and modifying the received locomotive remote control instructions dependent on the locomotive configuration; and

- 5 operating the locomotive according to the modified locomotive remote control instructions.

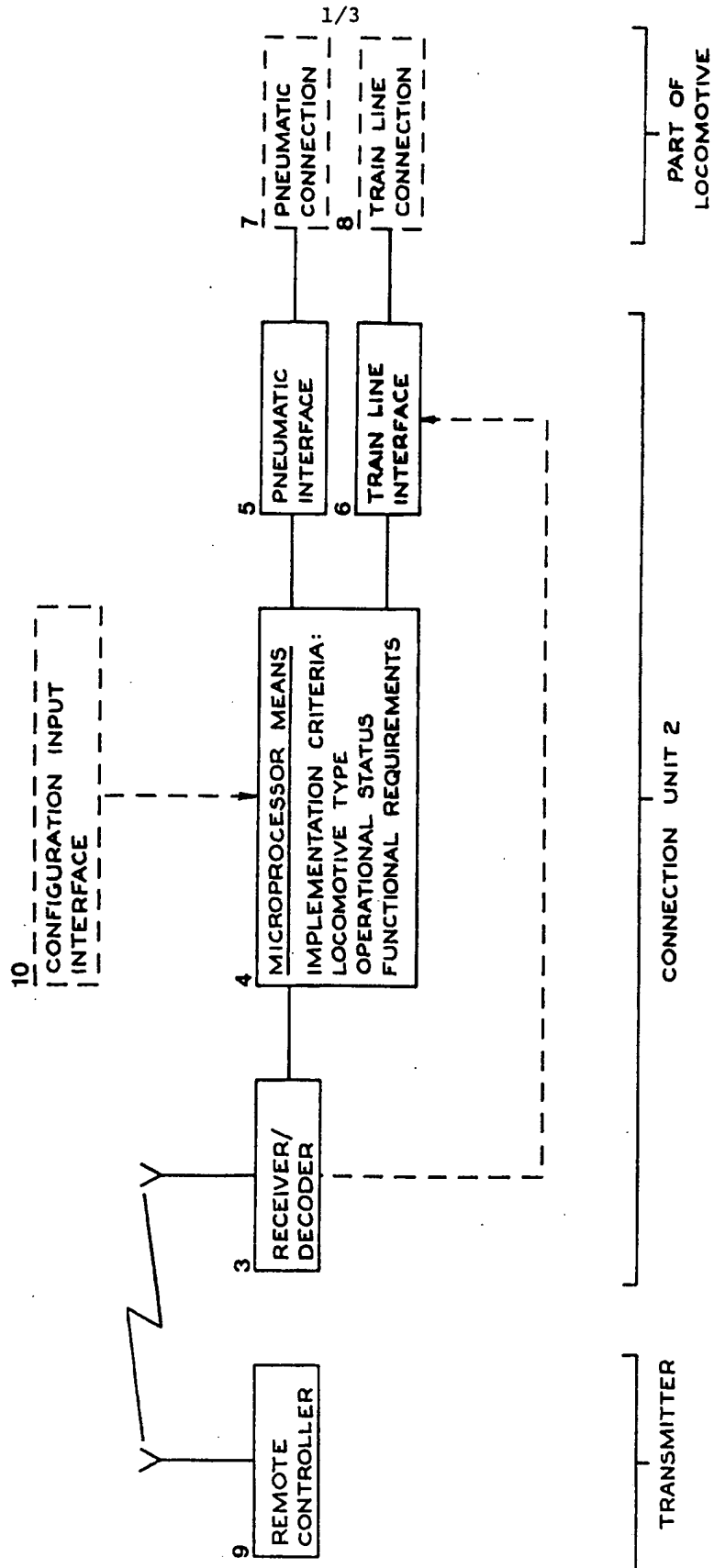


Figure 1

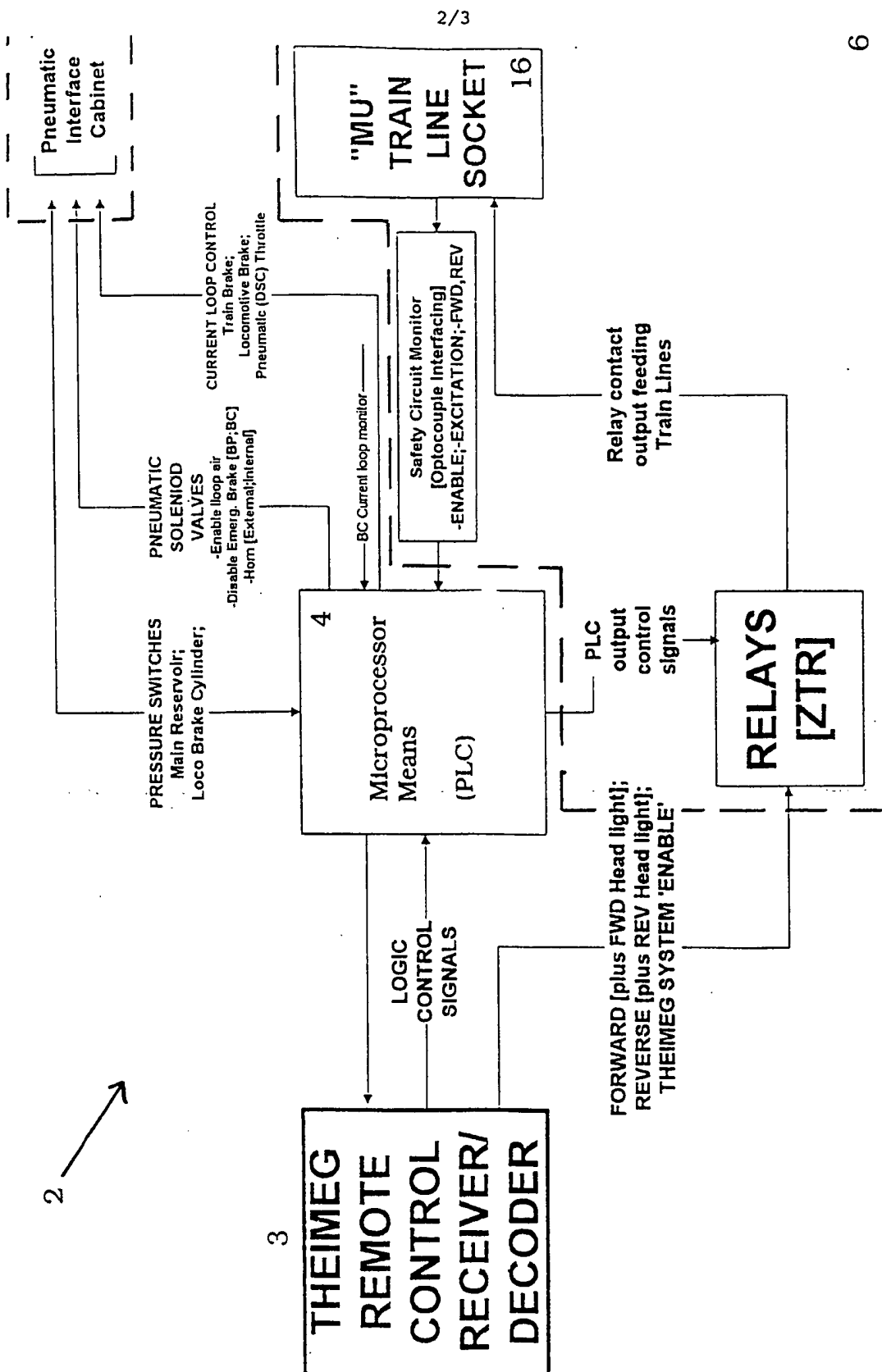


Figure 2

3/3

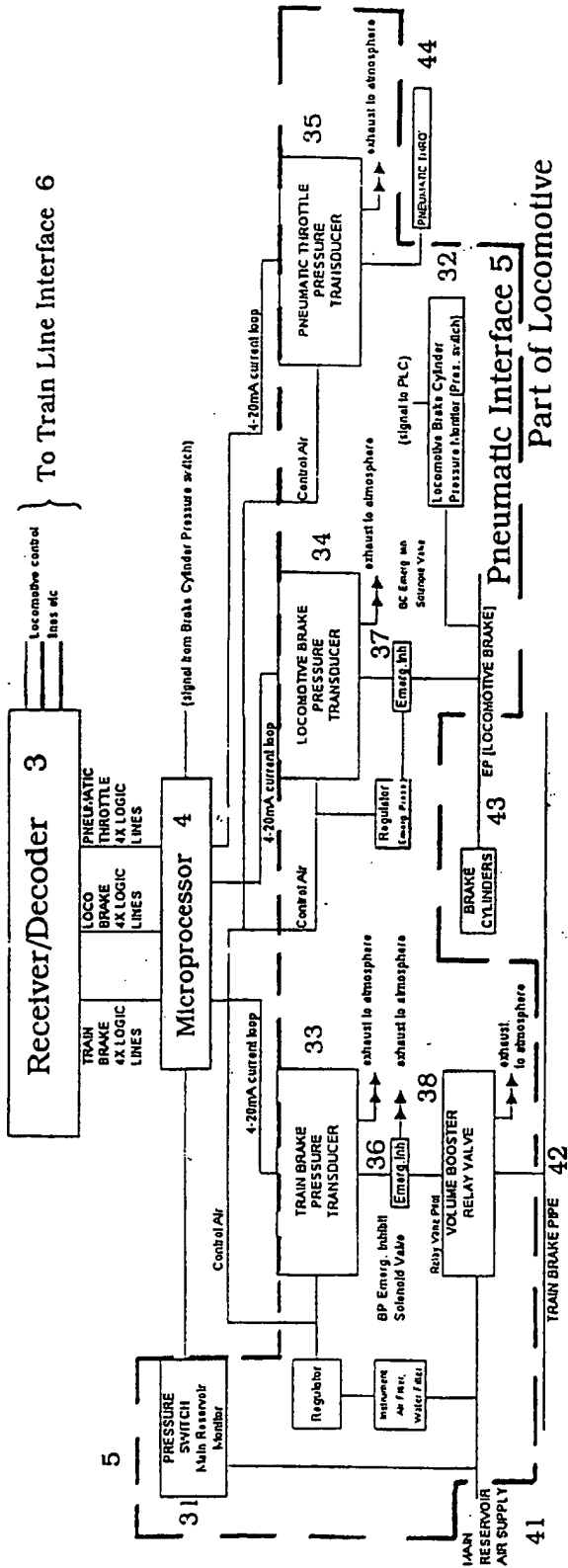


Figure 3